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A Concept for Holistic Optimization of Pre-Forging Processes in Automotive Crankshaft Production

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1. INTRODUCTION

In manufacturing, energy-saving is one of the most considerations which many production companies have been trying to reduce for getting the best competitive products with others. In order to guarantee competitiveness, the process chain performance and efficiency have to be measured and optimized. In traditional optimization, the designers and manufactures normally focus on single manufacturing steps, although there are several individual process steps. However, it is not sufficient to optimize the whole process chain because the inputs will be described the suitable outputs manufacturing step for a successful at the same time. In this paper, a holistic process optimization is proposed to optimize the energy consumption of pre-forging process which includes: inductions heating, hot shearing and roll forging process (Fig.1). Pre-forging process is very important to prepare for forging crankshaft step with high productivity, green technology. It requires a huge of amount energy to assure the energy of workpiece with large volume in the range of 1150~1250°C.

There are many researches about holistic design optimization to minimize energy efficiency. A method was applied to analyze energy in a broad way and design optimized [1], the energy scenarios have to follow the important scientific principles. Furthermore, to assure the final energy of heating process in production of automotive crankshaft, a holistic process was introduced and optimized base on simulation method [2]. The behavior of induction heating system was showed and energy is also minimized in final results with the consideration of process parameters.

Fig. 1 - Hot forging process of automotive crankshaft production line

To improve the energy efficiency in whole pre-forging process and obtain the target temperature for forging process at 1220^0C, this research proposes a holistic optimization method base on simulation and defines the interaction between each process for optimizing energy consumption.

2. HOLISTIC OPTIMIZATION OF PRE-FORGING PROCESSES IN AUTOMOTIVE CRANKSHAFT: A CONCEPT REVIEW

Products are usually manufactured in sequenced steps. For a holistic dimensioning of such process

chains, the knowledge of the transfer parameter of a single element of the process chain is important. The output of one manufacturing step is considered to be the input for the next following step. The collectivity of the transfer of parameters between two elements of process chain is the transfer-condition, which is described as technological interface in production system.

The holistic process is showed in Fig. 2. Firstly, each process will be analyzed to generate the engineering model and determine the interrelationship between each process after single optimization of each process. Additionally, base on engineering model, energy of each process will be analyzed and formulation with effect factor in each processes.

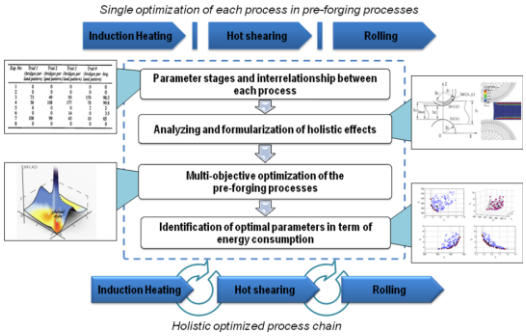

Fig. 2 Holistic optimization work flow of pre-forging processes in automotive crankshaft manufacturing.

Then, the multi-objective is used to combine 3 objective energy functions of induction heating, hot shearing and roll forging. Thereby all energy related input and output flows are explicitly considered. This allows an integrated evaluation combining objectives as availability of the system with energy consumption patterns respectively energy cost impact. Finally, the best process parameters are obtained through optimization of a single objective optimization problem. The total energy consumption will be compared to the current system with the target 73% in using energy efficiency of forging process.

4. CONCLUSION

The propose method for holistic optimization process chain of automotive crankshaft production focus on a process spanning consideration of technological dependences in term of energy saving. The single processes have been evaluated and the results will show the interaction between multiple manufacturing processes. By using the holistic optimization, the energy consumption has a high potential to be reduced and adaptability for new processes

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REFERENCES

1. Christian Deilmann, Klaus-Jürgen Bathe, “A Holistic Method to Design an Optimized Energy Scenario and Quantitatively Evaluate Promising Technologies for Implementation” International Journal of Green Energy - INT J GREEN ENERGY , vol. 6, no. 1, pp. 1-21, 2009
2. Hong-Seok Park, Xuan-Phuong Dang, “Optimization of The In-Line Induction Heating Process for Hot Forging in Terms of Saving Operating Energy” International Journal of Precision Engineering and Manufacturing, Volume 13, Issue 7, pp 1085-1093, 2012
3. H.K. Tönshoff, T. Friemuth, M. Zwick, A. Brandes, “Technological Interfaces of Industrial Process Chains”, Production Engineering IX/, 2 pp. 43–46, 2002
4. L. Monostori, Z.S.J. Viharos, “Hybrid, AI-and Simulation-Supported Optimisation of Process Chains and Production Plants”, Annals of the CIRP 50/, pp. 353–356, 2001